Chapter 3 Current Statewide Water Quality

3.1 Colorado's Major River Basins and Sub-Basins

The purpose of this chapter is to summarize at a statewide level the key information and water quality data presented at the basin scale in chapters 6–12 of this document. Although the exhibits presented in this chapter provide general information for basins, which add up to statewide totals, the basin plans in chapters 6–12 contain detailed breakouts of the information. For example, this chapter provides a summation of the basin plans' use classification data, such as total segments per use classification category, whereas the basin plans provide the information by segment. Readers desiring greater detail with respect to the water quality information presented in this chapter should consult the basin plans.

It should be noted that the SWQMP as a whole, and particularly the basins plans and this chapter, are based on readily available, peer-reviewed water quality information as contained in the 2010 Integrated Water Quality Monitoring and Assessment Report (2010 Integrated Report or Clean Water Act (CWA) section 305(b) report). Both the Water Quality Control Commission (WQCC) and the Water Quality Control Division (WQCD) are aware of many other water quality data sources. Organizations and other parties with water quality data are encouraged to get involved in "calls for data" for the biennally produced CWA section 305(b) reports. The data sources that are used in the forthcoming integrated reports will subsequently be used in future iterations of the SWQMP. The exhibits and basin summaries in this chapter also include information and data from numerous water quality regulations and policies. These references can, and will change, through time. Appendix A tabulates the adopted and effective dates of key water quality references to document the appropriate versions summarized in this chapter.

The state's river basins are large and have been broken into sub-basins for the purpose of presenting data in the Statewide Water Quality Management Plan (SWQMP). Exhibit 3-1 (at end of chapter) summarizes how the sub-basins have been apportioned. In future iterations of the SWQMP, the WQCD may further refine these sub-basins.

Some text and exhibits in this chapter and in the basin plans (chapters 6–12) were taken directly or adapted with permission from material in recent reports from the Colorado Water Conservation Board (CWCB). In 2003, the Colorado General Assembly authorized the CWCB to implement the Statewide Water Supply Initiative (SWSI), an 18-month basin-by-basin investigation of the state's existing and future water needs. As part of that effort, the CWCB assembled water users (farmers, ranchers, municipalities, industrial users, recreationalists, and environmentalists) to plan for the future. That effort resulted in the completion of the Statewide Water Supply Initiative Phase I Report in November 2004 and a Phase II report in November

¹ The Integrated Reports are prepared by the Water Quality Control Division (WQCD) on a biennial basis and are approved by the Water Quality Control Commission (WQCC) as Regulation No. 93: *Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List*, 5 CCR 1002-93 (WQCC 2010h; WQCD 2010a).

2007. Both reports focus on all water uses, not just municipal and industrial (M&I). Since that time, the CWCB has undertaken another investigation to project M&I surface water use needs to the year 2050 for the state. The result of that investigation is reported in the document, *State of Colorado 2050 Municipal and Industrial Water Use Projections*, dated July 2010. The report is part of the Basin Roundtables' assessment of consumptive water needs in the state as required by the Water for the 21st Century Act, which was passed by the Colorado legislature in 2005 (CWCB 2010).

3.1.1 Location and Physical Setting of the State's Major River Basins

The state of Colorado forms a nearly perfect square and encompasses 104,247 square miles or over 66.7 million acres. The state's geography is diverse, ranging from rugged, mountainous terrain to foothills, plains, plateaus, mesas, and canyons (CSA N.d.). The state's ecological diversity is enormous (Chapman et al. 2006). The Continental Divide runs north to south along the Rocky Mountains through west-central Colorado, creating a western slope and an eastern slope. Colorado's mean elevation is 6,800 feet. Its highest point is Mt. Elbert at 14,440 feet, southwest of Leadville; its lowest point is at 3,315 feet on the Arikaree River at the Kansas border. Mt. Elbert is the 14th highest peak in the United States, including mountain peaks in Alaska. There are 58 mountain peaks in Colorado over 14,000 feet high and more than 1,000 over 10,000 feet high (CSA 2010).

Colorado is home to seven major river basins, as shown in exhibit 3-2 (at end of chapter). Four of the seven rivers (Arkansas, Platte, Republican, and Rio Grande) flow east from the Continental Divide toward the Gulf of Mexico. The remaining three rivers—the Colorado, Green, and San Juan—flow west of the Continental Divide toward the Pacific Ocean. The headwaters of six of the seven rivers— Arkansas, Colorado, Green, Platte, Rio Grande, and San Juan—originate in Colorado's mountains. There are approximately 105,344 total stream miles statewide (WQCD 2010a), and additional key statistics regarding each of the basins are provided in exhibit 3-3.

Extract of the formation for construct of the public									
Basin	Rivers and	d Streams	Lakes and	Reservoirs	Number of				
(basin plan chapter number)	Surface Area In Square Miles ¹	Stream Length in Miles ²	Number Assessed	Corresponding Acres ^{3,4}	Groundwater Aquifers ¹				
Arkansas River (ch. 6)	28,268	25,592	24	60,171	6				
Colorado River (ch. 7)	17,830	24,708	33	49,006	5				
Green River (ch. 8)	10,528	13,796	22	22,251	7				
San Juan River (ch. 9)	10,169	5,805	11	15,969	3				
Rio Grande River (ch. 10)	7,543	6,875	10	5,623	2				
Platte River (ch. 11)	20,306	22,907	71	95,588	13				
Republican River (ch. 12)	9,404	5,618	2	7,668	2				
Total All Basins	104,048	105,301	173	256,276	38				

Exhibit 3-3. Key Statistics for Colorado's Major River Basins

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Source: CWCB 2004.

² Source: WQCD 2002.

³ Sources: WQCC 2010h; WQCD 2010a.

⁴ The number of lakes/reservoirs and the corresponding acres only include the lakes that have been assessed by WQCD and do not reflect all of the lakes/reservoirs present in the basins.

² The exhibit shows the 7 major river basins in Colorado and the state's water quality planning regions as discussed in chapter 2, "Water Quality Management and Planning in Colorado."

3.1.2 Ecology

There are six level III ecoregions and 35 level IV ecoregions in Colorado, many of which extend into ecologically similar areas in adjacent states (Chapman et al. 2006). The six level III ecoregions are the Wyoming Basin, Colorado Plateaus, Southern Rockies, Arizona/New Mexico Plateau, High Plain, and Southwestern Tablelands. Ecoregions are important from a land and water management perspective because they take into account spatial patterns along with biotic and abiotic factors that affect or illuminate differences in ecosystem quality and integrity (Wilken 1986 and Omernik 1987, 1995, cited in Chapman et al. 2006). Resource assessment and management strategies are strengthened by integrating both ecoregional and watershed frameworks. Using one framework alone can be limiting. Watersheds are "...topographic areas within which apparent surface water runoff drains to a specific point on a stream or to a waterbody such as a lake" (Omernick and Bailey 1997). Topographic areas, however, generally do not contain aggregations of similar geologic and geographic features, but ecoregions do.

Exhibit 3-4 shows the percentage of each basin that lies within the level III ecoregions. Each of these six ecoregions is divided further into level IV ecoregions. The physiography, geology, soils, climate, vegetation, and land use and land cover of the level IV ecoregions are summarized in appendix B.

Basin Arizona / New Colorado Southern Southwestern (basin plan chapter **Wyoming Basin High Plains Plateaus** Rockies Mexico Plateau **Tablelands** number) Arkansas River (ch. 6) 23% 18% 59% --Colorado River (ch. 7) 29% 71% Green River (ch. 8) 30% 38% 32% 48% --52% --San Juan River (ch. 9) ----Rio Grande River (ch. 10) 56% 44% Platte River (ch. 11) 37% 52% 10% 1% Republican River (ch. 12) 100% --

Exhibit 3-4. Percentage of Basins in Level III Ecoregions

Source: Chapman et al. 2006.

Endangered and threatened species and species of federal and state concern reside within each of Colorado's seven river basins, as summarized in exhibit 3-5. Across the state, there are 32 federal and 74 state endangered, threatened and candidate species. All but three of the species (Boreal Toad, Gray Wolf, and Grizzly Bear) occur in one or more of the major river basins. As a group, fish have the greatest number of endangered, threatened and candidate species (23). Birds and plants follow fish at 19 and 17, respectively. Basin-specific lists of the endangered, threatened and candidate species are provided in chapters 6–12.

Exhibit 3-5. Endangered, Threatened and Candidate Species by Type by Basin

			River Basins							
Common Name	Scientific Name	Status*	Arkansas (Ch. 6)	Colorado (Ch. 7)	Green (Ch. 8)	San Juan (Ch. 9)	Rio Grande (Ch. 10)	Platte (Ch. 11)	Republican (Ch. 12)	
Amphibians										
Boreal Toad	Bufo boreas boreas	SE								
Northern Cricket Frog	Acris crepitans	SC						•	•	
Great Plains Narrowmouth Toad	Gastrophryne olivacea	SC	•							
Northern Leopard Frog	Rana pipiens	SC	•	•	•	•	•	•	•	
Wood Frog	Rana sylvatica	SC		•				•		
Plains Leopard Frog	Rana blairi	SC	•						•	
Couch's Spadefoot	Scaphiopus couchii	SC	•							
Birds										
Whooping Crane	Grus americana	FE, SE	•	•	•	•	•	•	•	
Least Tern	Sterna antillarum	FE, SE	•	•	•	•		•	•	
Southwestern Willow Flycatcher	Empidonax traillii extimus	FE, SE	•	•	•	•	•	•		
Plains Sharp-Tailed Grouse	Tympanuchus phasianellus jamesii	SE						•		
Piping Plover	Charadrius melodus circumcinctus	FT, ST	•					•	•	
Bald Eagle	Haliaeetus leucocephalus	SC	•	•		•	•	•	•	
Mexican Spotted Owl	Strix occidentalis lucida	FT, ST	•	•	•	•	•	•		
Burrowing Owl	Athene cunicularia	ST	•	•		•	•	•	•	
Lesser Prairie-Chicken	Tympanuchus pallidicinctus	ST	•		•			•		
Western Yellow-Billed Cuckoo	Coccyzus americanus	SC	•	•	•	•		•	•	
Greater Sandhill Crane	Grus canadensis tabida	SC	•	•	•	•	•	•	•	
Ferruginous Hawk	Buteo regalis	SC	•	•	•	•	•	•	•	
Gunnison Sage-Grouse	Centrocercus minimus	SC		•		•	•			
American Peregrine Falcon	Falco peregrinus anatum	SC	•	•	•	•	•	•	•	
Greater Sage Grouse	Centrocercus urophasianus	SC		•	•	•	•	•		
Western Snowy Plover	Charadrius alexandrinus	SC	•	•		•		•	•	
Mountain Plover	Charadrius montanus	SC	•	•	•		•	•	•	
Long-Billed Curlew	Numenius americanus	SC	•	•	•	•	•	•	•	
Columbian Sharp-Tailed Grouse	Tympanuchus phasianellus columbianus	SC			•					
Fish							•			
Bonytail Chub	Gila elegans	FE, SE		•	•					
Razorback Sucker	Xyrauchen texanus	FE, SE		•	•					
Humpback Chub	Gila cypha	FE, ST		•	•					
Colorado Pikeminnow	Ptychocheilus lucius	FE, ST		•	•					
Greenback Cutthroat Trout	Oncorhynchus clarki stomias	FT, ST	•					•		

						River Basins			
Common Name	Scientific Name	Status*	Arkansas (Ch. 6)	Colorado (Ch. 7)	Green (Ch. 8)	San Juan (Ch. 9)	Rio Grande (Ch. 10)	Platte (Ch. 11)	Republican (Ch. 12)
Rio Grande Sucker	Catostomus plebeius	SE	(CII. 0)	(cii. 7)	(CII. 0)	(Cii. 3)	(Cii. 10)	(CII. 11)	(CII. 12)
Lake Chub	Couesius plumbeus	SE						•	•
Plains Minnow	Hybognathus placitus	SE	•					•	
Suckermouth Minnow	Phenacobius mirabilis	SE	•					•	•
Northern Redbelly Dace	Phoxinus eos	SE						•	
Southern Redbelly Dace	Phoxinus erythrogaster	SE	•						
Brassy Minnow	Hybognathus hankinsoni	ST	•					•	•
Common Shiner	Luxilus cornutus	ST						•	
Arkansas Darter	Etheostoma cragini	ST	•						
Mountain Sucker	Catostomus playtrhynchus	SC		•	•				
Plains Orangethroat Darter	Etheostoma spectabile	SC	•						•
Iowa Darter	Etheostoma exile	SC		•				•	
Rio Grande Chub	Gila pandora	SC		•			•		
Colorado Roundtail Chub	Gila robusta	SC		•	•	•			
Stonecat	Noturus flavus	SC	•					•	•
Colorado River Cutthroat Trout	Oncorhynchus clarki pleuriticus	SC		•					
Rio Grande Cutthroat Trout	Oncorhynchus clarki virginalis	SC					•		
Flathead Chub	Platygobio gracilus	SC	•						
Mammals									
Gray Wolf ¹	Canis lupus	FE, SE							
Black-Footed Ferret	Mustela nigripes	FE, SE	•	•	•	•	•	•	
Grizzly Bear ¹	Ursus arctos	FT, SE							
Preble's Meadow Jumping Mouse	Zapus hudsonius preblei	FT, ST	•					•	
Lynx	Lynx canadensis	FT, SE	•	•	•	•	•	•	
Wolverine	Gulo gulo	SE	•	•	•	•	•	•	
River Otter	Lontra canadensis	ST	•	•		•		•	
Kit Fox	Vulpes macrotis	SE		•	•	•			
Townsend's Big-Eared Bat	Corynorhinus townsendii pallescens	SC	•	•		•		•	
Black-Tailed Prairie Dog	Cynomys ludovicianus	SC	•					•	•
Botta's Pocket Gopher	Thomomy bottae rubidus	SC	•	•		•			
Northern Pocket Gopher	Thomomys talpoides macrotis	SC	•	•	•		•	•	•
Swift fox	Vulpes velox	SC	•					•	•
Reptiles									
Triploid Checkered Whiptail	Cnemidophorus neotesselatus	SC	•						
Midget Faded Rattlesnake	Crotalus viridis concolor	SC	•	•	•	•	•	•	•

			River Basins						
Common Name	Scientific Name	Status*	Arkansas (Ch. 6)	Colorado (Ch. 7)	Green (Ch. 8)	San Juan (Ch. 9)	Rio Grande (Ch. 10)	Platte (Ch. 11)	Republican (Ch. 12)
Longnose Leopard Lizard	Gambelia wislizenii	SC		•	•	•			
Yellow Mud Turtle	Kinosternon flavescens	SC	•	•					•
Common King Snake	Lampropeltis getula	SC	•						
Texas Blind Snake	Leptotyphlops dulcis	SC	•			•			
Texas Horned Lizard	Phrynosoma cornutum	SC	•						
Roundtail Horned Lizard	Phrynosoma modestum	SC	•						
Massasauga	Sistrurus catenatus	SC	•						•
Common Garter Snake	Thamnophis sirtalis	SC						•	•
Mollusks									
Rocky Mountain Capshell	Acroloxus coloradensis	SC						•	
Cylindrical Papershell	Anodontoides ferussacianus	SC						•	
Plants									
Milk-vetch, Mancos	Astragalus humillimus	FE		•		•			
Penland Beardtongue	Penstemon penlandii	FE		•					
Clay-loving Wild-buckwheat	Eriogonum pelinophilum	FE		•					
Knowlton Cactus	Pediocactus knowltonii	FE				•			
North Park Phacelia	Phacelia formosula	FE						•	
Penland Alpine Fen	Eutrema penlandii	FT	•	•				•	
Uinta Basin Hookless Cactus	Selerocactus glaucus	FT		•	•				
Mesa Verde Cactus	Selerocactus mesae-verdae	FT				•			
Colorado Butterfly Plant	Gaura neomexicana var. coloradensis	FT						•	
Ute Landies'-tresses	Spiranthesis diluvialis	FT			•			•	
Dudley Bluffs Bladderpod	Lesquerella congesta	FT			•				
Dudley Bluffs Twinpod	Physaria obcordata	FT			•				
Slender Moonwort	Botrychium lineare	FC	•						
DeBeque Phacelia	Phacelia submutica	FC		•					
Sleeping Ute Mild-vetch	Astragalus tortipes	FC				•			
Graham Beardtongue	Penstemon grahamii	FC			•				
White River Beardtongue	Penstemon scariosus albifluvis	FC			•				

*Status Codes:

FE = Federally Endangered SE = State Endangered FT = Federally Threatened ST = State Threatened

SC = State Special Concern (not a statutory category)

¹ As of September, 1989, the Colorado Wildlife Commission (policy-makers for the Division of Wildlife) opposes reintroduction of wolves and grizzly bears to Colorado because these species would be in conflict with livestock, human welfare and wildlife resources. If reintroduction of these species to Colorado is ever included in a national recovery plan, the Colorado Wildlife Commission might review its position.

3.1.3 Climate

The climatic conditions vary significantly across Colorado because of a variety of factors, including latitude, distance from large waterbodies, elevation, topography, and winter storm track position. Because Colorado is land-locked and far away from any ocean, it generally has a dry climate with large seasonal temperature variations. Localized climatic variations depend primarily on elevation and topography (CGS 2003).

Precipitation across the state also varies tremendously. It averages from less than 12 inches to over 60 inches annually. Statewide, Colorado averages 17 inches of precipitation per year. The unpredictability of winter storms in the mountains and winter and spring storms in the eastern plains, however, has caused the state to have significant variations in year-to-year annual precipitation and a long history of droughts (CGS 2003).

The eastern side of Colorado is relatively flat and is generally characterized as having abundant sunshine, low relative humidity, large daily temperature variations, little precipitation, and high to moderate winds. The valleys and basins at elevations below 9,000 feet exhibit semiarid conditions, with average precipitation ranging from 8 to 18 inches annually. Areas with elevations above 9,000 feet receive more precipitation, averaging in excess of 32 inches annually (CGS 2003). Flash flooding and hail damage from intense summer thunderstorms can be a concern, particularly along the eastern slopes and foothills of the mountains (Doesken et al. 2003).

The location of the Rocky Mountains in the central portion of the state plays a significant role in the climatic differences between the eastern and western parts of the state. Pacific winter storms typically track from west to east across the mountains. Because cold air retains less moisture, as storms move over the Rocky Mountains more precipitation is produced on the western side of the range while drier air with less precipitation is pushed to the eastern side. Precipitation in the mountains averages from 30 to over 60 inches annually. Restricted air movement in the mountains can lead to extremely low temperatures in the mountain valleys (CGS 2003).

Farther away from the mountains on the western side of the state, winter weather is colder but calmer and less variable than that east of the mountains. The valleys of west-central and southwest Colorado receive abundant sunshine, and the winter climate is not harsh. Summer afternoon temperatures can exceed 100 degrees Fahrenheit at elevations below 5,500 feet. Precipitation west of the Continental Divide is more evenly distributed throughout the year as compared to the eastern plains (Doesken et al. 2003).

3.1.4 Land Ownership and Land Cover/Use

Land ownership in the state is a mix of private, state, federal, and tribal. Exhibit 3-6 shows the percentage of ownership in each of the categories for each of the state's seven major river basins. The Republican River Basin has the highest percentage of private lands (92%), followed by the Arkansas River Basin (70%). The Arkansas River Basin also has the highest proportion of state lands (10%). The San Juan River Basin is the only basin with tribal lands; they make up 17% of the basin. The federal government owns substantial portions of land in the Colorado, Green, San Juan, and Rio Grande basins.

Basin **Federal** Tribal **Private** State (basin plan chapter no.) Arkansas River (ch. 6) 70% 10% 20% Colorado River (ch. 7) 26% 1% 73% Green River (ch. 8) 35% 5% 60% San Juan River (ch. 9) 18% 2% 63% 17% Rio Grande River (ch. 10) 40% 54% Platte River (ch. 11) 62% 8% 30% Republican River (ch. 12) 93%

Exhibit 3-6. Land Ownership by Basin

Source: USGS 2001.

Land cover in Colorado is summarized in exhibit 3-7. Grassland and forest are the predominant land cover types in the state, covering approximately 39% and 28% of the state, respectively.

Exhibit 3-7. Colorado Land Cover Data

Land Cover	Area (sq. miles)	Percent of Total
Grassland	41,053	39.4%
Forest	29,577	28.4%
Shrubland	16,883	16.2%
Planted/Cultivated	13,737	13.2%
Barren	1,221	1.2%
Developed	922	0.9%
Open Water	592	0.6%
Wetland	81	0.1%
Total	104,066	100%

Sources: CWCB 2004; USGS 2001.

3.1.5 Demographic and Socioeconomic Conditions

Historically, Colorado's economy was based on mining, beginning with gold in 1858 and moving to silver, uranium, coal, molybdenum and petroleum in later years (CSA 2010). Today, Colorado generates approximately four-fifths of its revenue through service industries,³ and approximately one-fifth of its revenue through farming. Colorado is one of the "top 10" states in the nation in terms of livestock production (Netstate 2011). The other agricultural products produced in the state include grains, dairy products, fruit and vegetables. The leading manufactured products in the state are scientific instruments, while computers and communications equipment are the leading types of machinery manufactured (Netstate 2011).

Colorado has 64 counties. The 2000 U.S. Census reported the state's population as increasing 30.6% from the 1990 census to 4.3 million. Colorado's population was estimated in 2008 as 5.1 million, representing an additional increase of 18.6% from the 2000 census. The Front Range urban corridor contains the greatest proportion of Colorado's population. The cities of Denver

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³The leading activities in terms of gross state product in the service industry category include private health care, hotels and ski resorts, engineering, legal services, and software development. Finance, insurance and real estate follow, with Denver serving as an important regional bank and finance hub. Wholesale and retail trade services also play a role in the service industry category (Netstate 2011).

(554,636), Colorado Springs (360,890), Aurora (276,393), Lakewood (144,126), and Fort Collins (118,652) have the highest populations (DOLA 2010; U.S. Census 2009). There are, however, areas in the state with one or fewer persons per square mile (CGS 2003).

Between the years 2008 and 2050, the state of Colorado is projected to grow from approximately 5.1 million people to 9.1 million people, an increase of 78% (CWCB 2010). Exhibit 3-8 shows the population projections by river basin between 2008 and 2050 under medium economic assumptions. These projections indicate that the Green, Colorado and the San Juan River Basins will likely experience the greatest proportional increases in population during the period, followed by the Arkansas, Platte, Rio Grande and Republican River Basins

Exhibit 3-8. Population Projections 2008/2009^{1,2} to 2050 by Basin, Medium-Growth Scenario

Basin ¹ (basin plan chaper no.)	2008/2009 ^{2,3}	2050	Percent Change 2008 /2009 ^{2,3} to 2050	Percent Average Annual Growth Rate
Arkansas River ² (ch. 6)	948,000	1,688,000	78%	1.86%
Colorado River ³ (ch. 7)	380,689	945,400	148%	3.62%
Green River ² (ch. 8)	45,000	117,000	160%	3.81%
San Juan River ² (ch. 9)	126,299	270,160	114%	2.71%
Rio Grande River ² (ch. 10)	50,000	80,000	60%	1.43%
Platte River ³ (ch. 11)	3,500,000	5,900,000	69%	1.67%
Republican River ³ (ch. 12)	33,934	47,206	39%	0.95%
Statewide	5,083,922	9,047,766	78%	1.88%

¹ The CWCB delineates some of their basins differently from the SWQMP. The basins that match 100% include the Arkansas, Green (called Yampa by CWCB), and Rio Grande River Basins. The CWCB San Juan River Basin matches the SWQMP's San Juan except for one 8-digit hydrological unit code. For the purposes of this exhibit, the two basins are treated as one and the same. The CWCB information presented in this exhibit for the Colorado, Platte and Republican River Basins has been adjusted, due to basin boundary differences, as follows: (a) The data in the exhibit for the Colorado River Basin is the summation of CWCB's Colorado and Gunnison basin data sets, and (b) the SWQMP Platte and Republican River Basins are 66% and 34%, respectively, of the summation of CWCB's North Platte and South Platte data (based on area).

Exhibit 3-9 (at end of chapter) presents projections of employment by sector in each of the state's major river basins from 2007 to 2050. It is projected that by 2050 slightly more than half of all the jobs statewide (52%) will be in traditional basic industries, and slightly less than half (48%) are projected to be resident service jobs. Of the basic jobs, agriculture, mining, manufacturing, and government sector jobs are projected to increase through 2050, but the percentage of jobs in these sectors as a portion of total jobs will decrease compared to 2007 levels. The major drivers of growth in the state will be household basic jobs (jobs created through the spending of retirees, public assistance recipients, investment income recipients, and

²The population data for the Arkansas, Green, San Juan, and Rio Grande are from 2008 (CWCB 2010).

³The population data for the Colorado, Platte, and Republican River Basins are from 2009 (DOLA 2010). Sources: CWCB 2010; DOLA 2010.

commuters) and regional and national service jobs. Household basic jobs will experience a large amount of growth mainly due to the aging of the population. Of the household basic sectors, jobs based on retiree spending will grow by the largest number and at the fastest rate. Regional and national service jobs will be a leading sector of growth in the state due to (1) the assumption of moderate economic growth in the United States; (2) the growth of Colorado service sectors (healthcare, technology, and construction) as a result of U.S. economic growth; and (3) the development of mining, renewable fuels, and other high-technology sectors. Tourism is also expected to grow in importance in Colorado by 2050, because of moderate growth of the U.S. economy, international economic expansion, and the identity of Colorado as a tourist destination (CWCB 2010).

3.1.6 Water Withdrawals

In 2005 the U.S. Geological Survey (USGS), in cooperation with the CWCB, estimated total surface water and groundwater use in Colorado to be approximately 13,500 million gallons per day (Mgal/d). Use was estimated for the following categories: agriculture (irrigation for crops and livestock), irrigation for golf courses, public supply, domestic, industrial, mining, and thermoelectric power. Exhibit 3-10 shows total water withdrawals by basin for these water use categories. Almost 91% of the water withdrawn was used for agricultural purposes in each of the basins and for the state as a whole (12,355 Mgal/d). The second predominant use for the state as a whole was for public supply at 864 Mgal/d (6%).

Basin				Water Use C	Categories			
(basin plan chapter number)	Agriculture (Crop Irrigation and Livestock)	Irrigation (Golf Course)	Public Supply ¹	Domestic ²	Industrial	Mining	Thermoelectric Power	Totals (Percent of Total Withdrawals in State)
Arkansas River (ch. 6)	1,861.16	5.36	225.86	7.53	73.82	3.10	36.90	2,213.70 (16.30%)
Colorado River ³ (ch. 7)	3,409.68	9.85	66.74	4.27	5.13	1.87	38.78	3,536.33 (26.04%)
Green River (ch. 8)	556.55	1.96	7.37	1.57	5.34	11.63	15.33	599.75 (4.42%)
San Juan River (ch. 9)	944.84	1.76	12.78	1.26	0.93	0.66	6.75	968.97 (7.13%)
Rio Grande River (ch. 10)	2,042.00	0.34	5.75	2.67	0.00	0.20	0.00	2,050.96 (15.10%)
Platte River ⁴ (ch. 11)	2,522.12	20.46	538.17	13.77	57.20	2.80	25.44	3,178.50 (23.41%)
Republican River ⁵ (ch. 12)	1,008.29	0.79	6.92	2.22	0.01	1.11	0.01	1,019.35 (7.51%)
Statewide ⁶	12,344.64	40.52	863.59	33.29	142.43	21.37	123.21	13,569.05

Exhibit 3-10. Total Water Withdrawals by Basin by Water Use Category in 2005 (in Mgal/d)

⁴ The term "public supply" refers to "community water systems" as that term is defined under the federal Safe Drinking Water Act. Community water systems (CWSs) are any water system that serves drinking water to at least 25 people for at least 60 days of the calendar year or has at least 15 service connections. In addition to providing water to domestic customers, CWSs also deliver water to commercial, industrial, and thermoelectric power users. The term "domestic" refers to the portion of the population not served by a "public supply" (USGS 2010).

Basin	Water Use C	Water Use Categories						
(basin plan chapter number)	Agriculture (Crop Irrigation and Livestock)	Irrigation (Golf Course)	Public Supply ¹	Domestic ²	Industrial	Mining	Thermoelectric Power	Totals (Percent of Total Withdrawals in State)
Percent of Statewide	90.98%	0.30%	6.36%	0.25%	1.05%	0.16%	0.91%	100%

¹ The term "public supply" is water supplied by a publicly or privately owned water system for public distribution, sometimes also known as a "municipal-supply system" or "community water system" (CWS). Any water system that serves drinking water to at least 25 people for at least 60 days of the calendar year or has at least 15 service connections is considered a public supply system. In addition to providing water to domestic customers, CWSs also deliver water to commercial, industrial, and thermoelectric power users (USGS 2010).

Source: USGS 2010.

Surface water is the dominant source for both public and industrial supply, but groundwater is being developed at an increasing rate. Groundwater is used most heavily in the eastern plains (especially the northeastern corner of the state) and in the San Luis Valley (CGS 2003).

The CWCB recently completed a projection of municipal and industrial surface water use needs to the year 2050 for the state.⁵ The projections will provide a basis for discussing and addressing the state's future M&I water needs. In this report, the CWCB has forecasted water demand from 2008 levels to 2050 under low, medium and high economic assumptions with and without passive conservation (see sidebar).⁶ The lowest forecasted water demand is with passive conservation under low growth economic assumptions, while the highest forecasted water demand is without passive conservation under high growth economic assumptions. The increase in water demand is 81% under medium economic assumptions without passive conservation.

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² The term "domestic" refers to water used for household purposes, such as washing clothes, cleaning dishes, drinking, food preparation, bathing, flushing toilets, and watering lawns and gardens that are not served by public-supply systems (USGS 2010).

³ The CWCB Colorado River Basin boundaries are different from the SWQMP Colorado River Basin boundaries. Water withdrawal data for the SWQMP Colorado River Basin was estimated by summing the CWCB Colorado River Basin data and the CWCB Gunnison River Basin data.

⁴The CWCB Platte River Basin boundaries are different from the SWQMP Platte River Basin boundaries. Water withdrawal data for the SWQMP Platte River Basin was estimated by summing the CWCB North Platte River Basin data and 66% of the CWCB South Platte River Basin data. The remaining 34% of the CWCB South Platte River Basin data is assigned to the SWQMP Republican River Basin water withdrawals.

⁵The CWCB South Platte River Basin boundaries include the entirety of the SWQMP Republican River Basin boundaries. Water withdrawal data for the SWQMP Republican River Basin was estimated assuming 34% of the CWCB South Platte River Basin water withdrawal is attributable to the Republican River.

⁶ Values may not add for totals due to rounding in source material.

⁵ In 2003, the Colorado General Assembly authorized the CWCB to implement the Statewide Water Supply Initiative (SWSI), an 18-month basin-by-basin investigation of the state's existing and future water needs. As part of that effort, the CWCB assembled water users (farmers, ranchers, municipalities, industrial users, recreationalists, and environmentalists) to plan for the future. That effort resulted in the completion of the *Statewide Water Supply Initiative* Phase I Report in November 2004 and a Phase II report in November 2007. Both reports focus on all water uses, not just municipal and industrial (M&I). Since that time, the CWCB has undertaken another investigation to project M&I surface water use needs to the year 2050 for the state. The result of that investigation is reported in the document *State of Colorado 2050 Municipal and Industrial Water Use Projections*, dated July 2010.

⁶ Passive conservation accounts for retrofits of existing housing and commercial construction with high-efficiency toilets, clothes washers, dishwashers, etc. as implementation of the baseline efficiency standards established under the 1992 National Energy Policy Act take place (CWCB 2010).

The CWCB also presented forecast information in their report for the state's major water basins and on a county basis. Exhibit 3-11 shows forecasted water demand by the seven major river basins under medium economic assumptions with and without passive conservation. The basins with the highest projected water demand in 2050 with and without passive conservation are the Platte, Arkansas, and Colorado. Of the seven major river basins, the Green River Basin is projected to experience the greatest percent increase in

Municipal and Industrial Water Demand Forecast
With and Without Conservation Under Low, Medium
and High Economic Assumptions

	2008 Water	2050 Water Demand (In Acre Feet Per Year)				
	Demand (In acre feet)	Low	Medium	High		
Without Passive Conservation	974,500	1,667,700 (71%)	1,761,800 (81%)	1,938,900 (99%)		
With Passive Conservation	974,500	1,512,700 (55%)	1,607,700 (65%)	1,786,800 (83%)		
CWCB 2010.						

water demand; 158% without passive conservation and 150% with conservation measures. The Rio Grande River Basin is projected to experience the least percent increase of the seven basins; 50% without passive conservation and 44% with such measures.

Exhibit 3-11. Municipal and Industrial and Self-Supplied Industrial Water Demand Forecast for Colorado

Exhibit 3-11. Municipal and industrial and Self-Supplied industrial water Demand Forecast for Colorado							
Fore	casted M&I Water Dem	and 2008 to 2050 und	der Medium Economic	Assumptions			
Basin (basin plan chapter numbers)	2008 Water Demand (AF)		Water Demand nic Assumptions	2050 Water Dem Conser Medium Econon			
		AFY	% Change	AFY	% Change		
Arkansas River (ch. 6)	196,000	349,000	78.06%	320,000	63.27%		
Colorado River ¹ (ch. 7)	83,000	193,000	132.53%	179,000	115.66%		
Green River ¹ (ch. 8)	12,000	31,000	158.33%	30,000	150.00%		
San Juan River ¹ (ch. 9)	22,000	47,000	113.64%	43,000	95.45%		
Rio Grande River (ch. 10)	18,000	27,000	50.00%	26,000	44.44%		
Platte River ¹ (ch. 11)	573,460	979,820	70.86%	884,920	54.31%		
Republican River ¹ (ch. 12)	70,040	134,980	92.72%	124,780	78.15%		
Statewide Totals	974,500	1,761,800	80.79%	1,607,700	64.98%		
	Forecasted SSI De	emands under Mediur	n Economic Assumptio	ons			
Basin	2008 Demand (AF)	2050 Demand					
Dasiii	2006 Demand (Ar)	(AF)	Percent Change				
Arkansas River	58,400	67,800	16.10%				
Colorado River ¹	5,740	10,090	75.78%				
Green River ¹	28,590	58,070	103.11%				
San Juan River ¹	2,310	5,310	129.87%				
Rio Grande River		1,500					
Platte River ¹	83,091	101,271	21.88%				
Republican River ¹	9,629	17,449	81.21%				
Statewide Totals	187,760	261,490	39.27%				

¹ The SWQMP Colorado equals the CWCB Colorado and Gunnison basins; the SWQMP Green equates to the CWCB Yampa-White basin; the SWQMP San Juan equals the CWCB Southwest basin; the SWQMP Platte equals the CWCB Metro, North Platte and 66% of the South Platte; and the SWQMP Republican equals 34% of the CWCB Platte.

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AF = acre-feet

⁷ The CWCB uses different boundaries from the WQCD for the state's major water basins. To get a sense of the forecasted demand using WQCD basin boundaries, the following rough assumptions were made: The SWQMP Colorado is a combination of CWCB's data for the Colorado and Gunnison basins; the SWQMP Greene equates to the CWCB Yampa-White basin; the SWQMP San Juan is equivalent to the CWCB Southwest basin; the SWQMP Platte combines CWCB's North Platte, Metro, and 66% of South Platte; and the SWQMP Republican is 34% of CWCB's South Platte. Interested readers should consult the basin plans in chapters 6-12 of the SWQMP or the CWCB document for additional detail.

AFY = acre-feet per year

The CWCB M&I report also includes projected self-supplied industry (SSI) demands between 2008 and 2050 under low, medium, and high economic assumptions. As summarized in exhibit 3-11, statewide SSI demands in 2008 were 187,760 acre-feet (AF) and are projected to increase to 261,490 AF under medium economic assumptions. SSI demand was highest in the South Platte, Arkansas, and Green River Basins in 2008 and is projected to be highest in these three river basins in 2050. The Rio Grande and San Juan River Basins had the least SSI demand in 2008 and are projected to remain in these positions relative to the state's other major basins in 2050. The San Juan River Basin, however, is projected to witness the greatest percent increase in SSI demand between 2008 and 2050 at approximately 130%. The San Juan is followed by the Green River Basin, which is forecasted to experience a 103% SSI demand increase. The percent increase in the Platte and Arkansas River Basins between 2008 and 2050 is relatively low when compared to the percent increases in the other basins, at approximately 16% and 22%, respectively.

3.1.7 Hydrography and Hydrology

3.1.7.1 Surface Geology

Colorado's geology ranges from the Precambrian era and period (from the origin of the earth around 4.6 billion years ago to approximately 543 million years ago) to the Cenozoic era (65 million years ago to the present) and Quatenary period (last 2 million years of geologic history—the Ice Age) (CGS 2003). Exhibit 3-12 at end of chapter is a general geologic map of Colorado It should also be noted that soils derived from the various shallow geologies and deposited materials are a prime consideration in water quality planning.⁸

3.1.7.2 Surface Water

The State Engineer's Office and the USGS maintain various stream gauges across the state of Colorado. In the Statewide Water Supply Initiative (SWSI) study, the CWCB selected gauges across the basins on a broad spatial scale to summarize historical flows in all but the WQCC-defined Republican River Basin. The results of CWCB's analyses are presented in each of the basin chapters (chapters 6–12). The basin plans also contain exhibits showing the locations of the gauges and the major surface water diversions and segments with decreased instream flow.

It should be noted that snowpack can have significant impacts and can cause variations in surface water quality and quantity on an annual basis. The snow survey program of the Natural Resources Conservation Service (NRCS) provides mountain snowpack data and streamflow forecasts for the western United States. Common applications of snow survey data include water supply management, flood control, climate modeling, recreation, and conservation planning. Additional information on the NRCS snow survey program can be found at http://www.co.nrcs.usda.gov/snow/.

⁸ Soil variations occur on a local and regional scale and should be taken into consideration when addressing water quality problems. Information on soil conditions can be found through the Natural Resources Conservation Service (NRCS) Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. The website can be used to access soil maps and soil descriptions, interpretations, and characteristics. The information can be used at a relatively broad scale as well as on a site-specific basis.

3.1.7.3 Wetlands

Wetlands cover approximately 1.5 percent of Colorado's land area or 1 million acres (USGS 1999). Over the past two centuries, Colorado, like much of the country, has lost a considerable amount of its wetlands acreage—one-half (Dahl 1990). Between one-third and one-half of Colorado's plant biodiversity is estimated to occur in the 1 million remaining acres of the state's wetlands (CNHP 2003).

Wetlands in Colorado are palustrine. They include forested wetlands in riparian areas and seeps and springs; scrub-shrub wetlands (e.g., willow carrs or thickets and bottomland shrublands); emergent wetlands (e.g., marshes, fens, alpine snow glades, and wet and salt meadows); and aquatic-bed wetlands in ponds and lakes (ASWM 2004). Exhibit 3-13 is a diagram of key features and habitats in the palustrine system. For more detailed information on the key features of the various palustrine wetlands, refer to the USGS's Northern Prairie Wildlife Research Center website at http://www.npwrc.usgs.gov/resource/wetlands/classwet/index.htm.

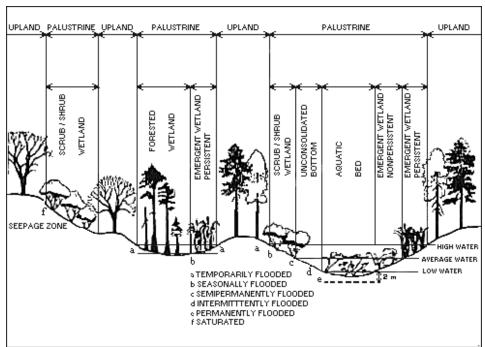


Exhibit 3-13. Features and Habitats in the Palustrine System

Source: Cowardin et al. 1979.

3.1.7.4 Groundwater

Colorado's primary aquifers are categorized into four basic types: (1) unconsolidated Quaternary-age alluvial aquifers associated with major river systems, (2) poorly consolidated or unconsolidated sediments, (3) consolidated sedimentary rock aquifers, and (4) volcanic and crystalline rock aquifers (CGS 2003). Exhibits 3-14 to 3-16 (at end of chapter) show the location and extent of Colorado's major Quaternary-age alluvial deposits (exhibit 3-14), major sedimentary rock aquifers and structural basins (exhibit 3-15), and crystalline, volcanic, valley-fill, and intermontane park aquifers (exhibit 3-16).

3.2 Water Quality Classifications and Standards

3.2.1 Surface Water

3.2.2.1 Regulations

The WQCD organizes its water quality assessment work according to the structure of the WQCC regulations and, thus, according to the seven major basins previously identified. Exhibit 3-17 provides a summary of the regulations that pertain to each of the seven major river basins. The classifications themselves can be found at http://www.cdphe.state.co.us/regulations/ wqccregs.

Regulation No. **Major River Basin Classifications and Numeric Regulatory Citation** (basin plan chapter numbers) Standards Arkansas River (ch. 6) Regulation No. 32 5 CCR 1002-32 Colorado River (ch. 7) Regulation Nos. 33, 34, 35, 5 CCR 1002-33, 1002-34, 1002-35 and and 37 1002-37 Green River (ch. 8) Regulation Nos. 33 and 37 5 CCR 1002-33 and 1002-37 San Juan River (ch. 9) Regulation No. 34 5 CCR 1002-34 Rio Grande River (ch. 10) Regulation No. 36 5 CCR 1002-36 Regulation Nos. 33 and 38 5 CCR 1002-33 and 1002-38 Platte River (ch. 11) Republican River (ch. 12) Regulation No. 38 5 CCR 1002-38

Exhibit 3-17. Water Quality Regulations by Major River Basin

Sources: WQCC 1997, 2010a to 2010h.

3.2.2.2 Total Segments, Stream Miles, and Lake Acres

Total Segments⁹

Colorado's seven major river basins contain a total of 803 segments¹⁰ (exhibit 3-18 at end of chapter). The Platte, Colorado and San Juan River Basins contain the greatest number of surface water segments at 218 (27%), 196 (24%), and 114 (14%), respectively. The Republican River has the fewest segments, with only eight for the entire basin.

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⁹ The Classifications and Numeric Standards (the regulations) often designate all surface water in a given area as a segment, meaning that some segments contain streams, lakes, and wetlands, or some combination of the above. Sometimes, the regulations identify a lake or reservoir as a stand-alone segment. To avoid confusion, the SWQMP simply tallies segments as surface water segments, meaning that these segments include lakes, rivers, streams, and wetlands.

¹⁰ The number of surface water segments is based on the applicable regulations. The stream miles are from appendix A of the 2010 Integrated Report (WQCC 2010h; WQCD 2010a). The WQCD often divides a segment in the regulations into multiple sub-segments for monitoring purposes. In these instances, the stream miles have been summed.

Total Stream Miles¹¹

Colorado's seven major river basins contain a total of 94,390 stream miles ¹²(exhibit 3-19 at end of chapter). Three river basins also contain the most stream miles as follows: the Platte River Basin at 18,590 miles (20%), the Colorado River Basin at 18,643 stream miles (20%), and the Arkansas River Basin at 21,913 stream miles (23%). The Green River Basin follows at 15%. The Republican River Basin contains the lowest percentage of overall stream miles at 5,655 miles (6%)

Lake Acres

Lakes are presented in WQCC's surface water quality classifications and standards regulations in several ways. A lake may be present alone as its own segment, as a combination of several lakes grouped into a segment, or as part of a segment that includes streams, lakes, and wetlands. The entire universe of lakes/reservoirs in Colorado is not explicitly denoted in the WQCC regulations, nor are the lakes/reservoirs fully denoted in the WQCD's biennial Integrated Reports. During each biennial cycle, the WQCD assesses and presents information for only a subset of lakes/reservoirs in the state. The 2010 Integrated Report indicates that the WQCD evaluated lakes/reservoirs with a total of 248,609 acres (exhibit 3-20).

Exhibit 3-20. Assessed Lake/Reservoir Acres

Basin (basin plan chapter numbers)	Combined Acres		
Arkansas River (ch. 6)	60,171		
Colorado River (ch. 7)	49,006		
Green River (ch. 8)	22,251		
San Juan River (ch. 9)	15,969		
Rio Grande River (ch. 10)	5,624		
Platte River (ch. 11)	95,588		
Republican River (ch. 12)	0		
Statewide	248,609		

Sources: WQCC 2010a to 2010h; WQCD 2010a.

3.2.2.2 Use Classifications

Generally, multiple uses are specified for any given water quality segment. Exhibit 3-21 (at end of chapter) provides a summary of the number of segments and stream miles and their use classifications by basin. The exhibit shows that WQCC has assigned 2,945 uses to the state's 803 water quality segments. This equates to an average of 3.7 uses per segment. Exhibit 3-22 below provides a summary of the proportion of segments to which WQCC has assigned a particular use classification. Agriculture and existing recreation are the most predominant uses assigned, while "undetermined for recreational use" is the least assigned category.

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¹¹ Only stream miles are summed for the 803 surface water segments, meaning that lake and wetland acreage is not included.

¹² The stream miles shown in these exhibits are based on the information in the latest water quality regulations and the 2010 Integrated Report. Other sections of this chapter may report stream miles from earlier documents.

No. of **Use Classification** Percent of Associated Stream Miles Segments 792 27% Agriculture 632 21.5% **Existing Recreation** Aquatic Life Cold Water 545 18.5% 533 18% Water Supply Aquatic Life Warm Water 243 8% Not Suitable for Recreation 106 4% Potential Recreation 66 2% **Undetermined for Recreational** 28 1%

Exhibit 3-22. Number of Waterbody Segments and Percent of Stream Miles by Use Classification Category

Sources: WQCC 2010h; WQCD 2010a.

3.2.2.3 Designations

Of the 803 segments, the WQCC has classified 59 (7%) as Outstanding Waters. The designated segments consist of 3,984 stream miles, or 0.085% of the total stream miles. The WQCC has also classified 153 segments as use-protected (19%). These designated segments add up to 42,838 stream miles, representing 0.9% of total stream miles across basins.

3.2.3 Lakes

3.2.3.1 Trophic Status

From July 2007 to July 2009 the WQCD monitored a total of 50 lakes and reservoirs across the state to evaluate their trophic status and to assess whether they were attaining their respective water quality standards. In addition, during the period from 1995 to 2006, the WQCD monitored other sets of lakes/reservoirs across the state to assess their trophic status and to determine whether water quality standards were being met.

The *trophic state* is a means of classifying lakes based on their level of biological productivity (especially algae) and nutrient status. Commonly used indicators of nutrient status and productivity include the amount of algae as measured by chlorophyll *a*, water transparency as measured by Secchi disk depth, and in-lake epilimnetic total phosphorus concentration. The WQCD broadly defines the various *trophic states* for the purposes of its analyses as follows:

- Oligotrophic. Lakes with few available nutrients and a low level of biological productivity. They are characterized by clear water, and they often support cold-water fish species.
- Mesotrophic. Lakes with moderate nutrient levels and biological productivity between oligotrophic and eutrophic. These lakes usually support warm-water fish species.
- **Eutrophic.** Lakes with high nutrient levels and a high level of productivity. These lakes typically support only warm-water fish species.
- Hypereutrophic. Lakes in an advanced eutrophic state.

As shown in exhibit 3-23, of the examined lakes and reservoirs, the majority (22 or 40%) were determined to be oligotrophic. These were followed by 15 as eutrophic (27%), 13 as mesotrophic (24%) and 5 as hypereutrophic (9%).

Total Number Basin **Number of** Number of Number of Number of Lakes or Sampling Oligotrophic Mesotrophic **Eutrophic** Hypereutrophic (basin plan chapter Reservoirs Year(s) Lakes Lakes numbers) Lakes Lakes Sampled Arkansas River 4 5 5 in 2008 0 0 1 (ch. 6) 1 between Colorado River 7 0 6 Λ 1 1997 to 2000 (ch. 7) 6 in 2008 Green River 4 in 2007² 7 4 2 0 1 (ch. 8) 4 in 2008² San Juan River 2 in 1999 6 4 1 1 0 (ch. 9) 4 in 2008 1 in 2000 Rio Grande River 6 5 between 0 0 5 1 (ch. 10) 2005 to 2006 1 between 1995 to 1998 2 in 1999 Platte River 3 in 2000 24 8 9 5 2 (ch. 11) 1 between 2007 and 2008 11 in 2007 6 in 2008 Republican River 0 0 0 0 None (ch. 12) Statewide 55 22 13 Various

Exhibit 3-23. Trophic Status of Measured Lakes and Reservoirs¹

Sources: WQCD 2002, 2008, and 2010.

3.2.3.2 Fish Tissue Studies

As part of its overall monitoring efforts, the WQCD also investigates fish tissues for the presence of contaminants that can be harmful to humans if ingested. The WQCD uses the monitoring data to issue fish consumption advisories (FCAs) to the public as warranted. During the period July 2007 to July 2009, the WQCD evaluated fish tissues from more than 112 waterbodies for mercury, selenium and arsenic. Exhibit 3-24 shows the number of lakes and reservoirs tested in each major river basin in addition to the species tested.

Exhibit 3-24. Fish Tissue Sampling by Basin

Basin (basin plan chapter number)	Number of Lakes and Reservoirs Assessed	Species Tested		
Arkansas River (ch. 6)	4	Black crappie (2) Channel catfish (2) Saugeye (2) Smallmouth bass (1)	Walleye (1) White bass (1) Wiper (2) Yellow perch (1)	
Colorado River (ch. 7)	4	Black crappie (1) Bluegill (1) Lake trout (1) Largemouth bass (1)	Northern pike (2) Smallmoth bass (2) White crappie (1) Yellow perch (2)	
Green River (ch. 8)	6	Black crappie (2) Bluegill (1) Brook trout (1) Largemouth bass (2)	Northern pike (4) Smallmoth bass (1) Walleye (1) Yellow perch (1)	

¹ Samples were taken at various times from 1997 to 2008. Source material does not specify the number of samples taken per waterbody

² One lake/reservoir was sampled in both 2007 and 2008.

Basin (basin plan chapter number)	Number of Lakes and Reservoirs Assessed	Species Tested		
San Juan River (ch. 9)	1	Black crappie Channel catfish Green sunfish	Largemouth bass Yellow perch White sucker	
Rio Grande River (ch. 10)	2	Brook trout (1) Brown trout (1)	Rainbow trout (2) Splake (1)	
Platte River (ch. 11)	6 (mercury only)	Largemouth bass (2) Sauger (1) Smallmouth bass (1)	Walleye (3) White bass (1) Wiper (1)	
Republican River (ch. 12)	0	None	None	
Republican River (ch. 12) 0 Statewide 23		Black crappie (6) Bluegill (2) Brook trout (2) Brown trout (1) Channel catfish (3) Green sunfish (1) Lake trout (1) Largemouth bass (5) Northern pike (6) Sauger (1)	Saugeye (2) Smallmouth bass (5) Splake (1) Walleye (5) White bass (2) White crappie (1) White sucker (1) Wiper (3) Yellow perch (5)	

Sources: WQCC 2010h; WQCD 2010a.

The reason the WQCD tests for the presence of mercury, selenium, and arsenic in fish tissue is because of the harmful human health effects that can occur if these parameters are ingested. In particular, mercury adversely affects wildlife and humans, especially children and women of childbearing age. It is also the leading cause of impairment in the nation's estuaries and lakes. Mercury was cited in nearly 80% of FCAs reported by the states in the 2000 National Listing of Fish and Wildlife Advisories. Although arsenic generally bio-accumulates in fish in its less toxic organic form, human exposure is still harmful. The U.S. Department of Health and Human Services (DHHS) has determined that arsenic is a known carcinogen, and human exposure can occur by ingesting water, soil, or air contaminated by the substance. Selenium is an essential dietary element that prevents damage to tissues by oxygen. However, it is toxic to both humans and animals when it is consumed in amounts higher than the recommended daily allowance, and excessive ingestion or exposure should be minimized (WQCD 2005).

Any waterbody that is issued an FCA is listed on the state's CWA section 303(d) list of impaired waters with aquatic life impairment. TMDLs must be completed for all impairments. Current FCAs are summarized in each of the basin plans in chapters 6–12 of this document. The majority of FCAs are for mercury exceedances of the action level of 0.5 parts per million (ppm).

3.2.4 Wetlands

The U.S. Fish and Wildlife Service (USFWS) is the principal federal agency charged with collecting data and reporting on the status and trends of the nation's wetlands. Toward this end, the USFWS has developed the National Wetlands Inventory (NWI). The agency develops a periodic national report on the status and trends of wetlands in the conterminous United States based on information in the database. To date, USFWS has developed four such reports: 1950s to 1970s, mid-1970s to mid-1980s, 1986 to 1997, and 1998 to 2004. They can be accessed at http://www.fws.gov/wetlands. The NWI is also a geospatial tool from which maps showing the location of wetlands can be developed. Exhibit 3-25 (at end of chapter) shows the location of wetlands as contained in the NWI for Colorado.

Between 1999 and 2003, the Colorado Natural Heritage Program (CNHP), in cooperation with Colorado State University and the Division of Wildlife of the Colorado Department of Natural Resources, undertook an effort to classify and characterize the state's wetlands. As part of this effort, the CNHP conducted wetland surveys and assessments in 35 counties in the state (exhibit 3-26). The CNHP has produced a final report documenting the study; it is available at http://www.cnhp.colostate.edu/download/documents/2003/wetland_classification_final_report_2003.p df. The results of the effort are also being summarized for the public in the form of a field guide to the state's wetland and riparian plant communities (CNHP 2003).

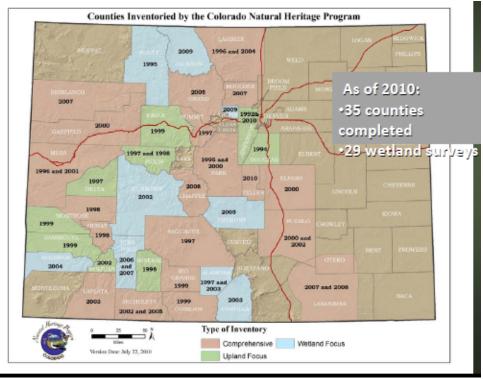


Exhibit 3-26. Counties Inventoried by the Colorado Natural Heritage Program

Source: Culver 2010.

The CNHP report identifies four hydrogeomorphic (HGM) classes and 10 groups of wetlands based on 184 plant associations. The plant associations are also ranked and prioritized in terms of imperilment and biodiversity significance. The HGM classification system groups wetland types that have similar characteristics and perform similar functions. The study identifies one group of Mineral Soil Flats Wetlands, three groups of Depressional Wetlands, two groups of Slope Wetlands, and four groups of Riverine Wetlands. It reflects a preliminary attempt to systematically classify and inventory wetlands in the state of Colorado. This type of information on wetlands can be used to assist land managers in developing functional evaluations, as well as in identifying the wetlands under their jurisdiction (CNHP 2003).

Colorado's Division of Wildlife (CDOW) undertakes a number of activities aimed at conserving the state's wetlands. One program, the Wetlands Wildlife Conservation Program (WWCP), focuses on preserving, restoring, enhancing, and creating wetlands throughout the state. This program particularly focuses on (1) protecting the role of wetlands in Colorado as important

feeding, breeding, migratory, and brooding habitat for water birds, and (2) providing recreational uses, such as hunting, fishing, and bird watching, through wetlands (CDOW 2008). The CDOW has created 11 focus area committees under the WWCP, 8 of which are currently active (CDOW 2010a). The committees provide a mechanism through which conservationists can share information on local wetlands, discuss wetland needs, and generate ideas for wetland protection and restoration projects. The CDOW reports that since WWCP's implementation in 1997, the program has enhanced or created 220,000 acres of wetlands and adjacent habitat (CDOW 2010c).

Through the Office of the State Conservationist, a number of NRCS programs that have the benefit of protecting wetlands are available to be implemented in the state. One of the primary programs is the Wetlands Reserve Program, a voluntary program under which landowners may sell a conservation easement or enter into a cost-share agreement with the U.S. Department of Agriculture (USDA) to restore and protect wetlands (NRCS 2010). More information on this program is available on the NRCS's website at http://www.co.nrcs.usda.gov/programs.

A study by NatureServe in 2005 found that many isolated wetlands throughout the United States are home to many at-risk plant and animal species, and nearly half of isolated wetland types are known to support at least one species protected under the Endangered Species Act. ^{13,14} Overall, NatureServe concluded that "geographically isolated wetlands" represent a considerable amount of ecological diversity present in the United States and provide habitat for a considerable portion of the nation's flora and fauna. In Colorado specifically, NatureServe identified 17 wetland types, six of which (35%) were identified as isolated. NatureServe further identified three at-risk plants in isolated wetlands in Colorado but no at-risk animals (NatureServe 2005).

Wetlands provide benefits to both people and wildlife, depending on their type and location in the landscape. They provide key habitat for waterfowl, songbirds, fishes, amphibians, mammals, and many species of plants. They filter pollutants such as sediment, nutrients, and heavy metals out of the water, thereby providing clean water to downstream communities. Wetlands provide for groundwater recharge and discharge, retain snowmelt water in the spring and release it in drier periods of the year, and capture stormwater runoff. Wetlands reduce opportunities for erosion and flooding. They also provide multiple recreational and educational opportunities (USEPA Region 8 2010).

3.2.5 Groundwater

¹³ NatureServe is a private conservation organization. It operates with a network of natural heritage programs or conservation data centers in all 50 U.S. states, Canada, Latin America, and the Caribbean. Collectively, NatureServe and the national heritage programs are the leading source for information about rare and endangered species and threatened ecosystems. For further information, go to http://www.natureserve.org/aboutUs/index.jsp.

¹⁴ In 2001 the U.S. Supreme Court held in *Solid Waste Agency of Northern Cook County vs. U.S. Army Corps of Engineers* (more commonly referred to as the SWANCC decision) that some wetlands and other waters considered to be "geographically isolated" from navigable waters no longer fell under the jurisdiction of the Clean Water Act (CWA). As a result of the decision, many states have passed their own laws to provide protection of geographically isolated wetlands. Colorado does not fall into this camp. Efforts have also been under way at the national level to change the definition of *navigable waters* under the CWA to include these wetland types. For further information on this topic, see the paper entitled *The SWANCC Decision: State Regulation of Wetlands to Fill the Gap* (Kusler 2004), available on the Association of State Wetland Manager's website at http://www.aswm.org/fwp/swancc/aswm-int.pdf.

In terms of water quality, WQCC is responsible for establishing basic and site-specific standards that pertain to groundwater. Other agencies, however, have responsibilities for implementing these standards. See chapter 2, "Water Quality Planning and Management in Colorado" for a more complete discussion of these issues.

3.2.5.1 Interim Narrative Standard

The Interim Narrative Standard in section 41.5(C)(6)(b)(i) of Regulation No. 41: *The Basic Standards for Groundwater* (5 CCR 1002-41) (WQCC 2009) is applicable to all groundwater for which the WQCC has not already assigned standards, with the exception of those groundwaters where the total dissolved solids (TDS) are equal to or exceed 10,000 milligrams per liter (mg/L). The Interim Narrative Standard is independent of and in addition to the statewide groundwater standards for radioactive materials and organic pollutants.

Until such time as use classifications and numeric standards are adopted for groundwater on a site-specific basis, the following standards apply for each parameter at whichever of the following levels is the least restrictive:

- Existing ambient quality as of January 31, 1994, or
- That quality which meets the most stringent criteria set forth in Tables 1 through 4 of Regulation No. 41: *The Basic Standards for Groundwater*.

The four tables from Regulation No. 41: *The Basic Standards for Groundwater* can be viewed online at http://www.cdphe.state.co.us/regulations/wqccregs for the following classified uses: Table 1: Domestic Water Supply—Human Health Standards; Table 2: Domestic Water Supply—Drinking Water Standards; Table 3: Agricultural Standards; and Table 4: Total Dissolved Solids Water Quality Standards.

3.2.5.2 Site-Specific Classifications and Standards

The WQCC has established a total of 46 site-specific groundwater classifications for various areas within the state's major river basins. The total number of classifications per basin is summarized in exhibit 3-28. Maps of the classified areas can be found in the basin plans in chapters 6–12 of this document.

Basin (basin plan chapter number)	Number of Site-Specific Groundwater Classifications
Arkansas River (ch. 6)	8
Colorado River (ch. 7)	2
Green River (ch. 8)	5
San Juan River (ch. 9)	0
Rio Grande River (ch. 10)	2
Platte River (ch. 11)	23
Republican River (ch. 12)	6
Statewide	46

Exhibit 3-28. Number of Site-Specific Groundwater Classifications by Major River Basin

3.2.5.3 Groundwater Quality

Each of the basin plans in chapters 6–12 of the SWQMP provide a brief overview of the major groundwater systems that coincide with each of the state's major river basins. Groundwater quality can be affected in a number of ways: harmful pollutants on the ground or underground can seep into groundwater; wastes can be injected into groundwater; and wastes can also leach from leaking tanks and storage devices. Groundwater quality is also affected by the rates at which it is pumped and recharged (see exhibit 3-29).

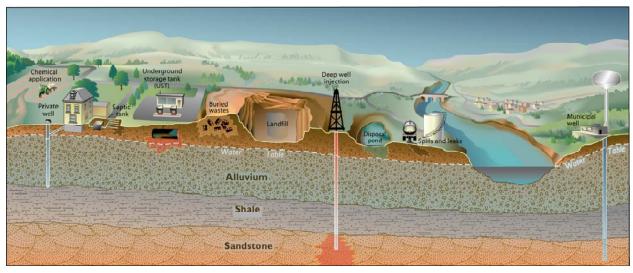


Exhibit 3-29. Potential Sources of Groundwater Contamination

Source: CGS 2003.

3.3 Surface Water Quality Stressors and Sources

3.3.1 Impairments

The 2010 Integrated Report identified statewide a total of 183 individual stream segments with one or more impairments representing 21,200 stream miles, or 23% and 22.5% of the total segments and stream miles in the state, respectively. As shown in exhibit 3-30 (at end of chapter), the majority of the classified uses not being attained are aquatic life cold (53%) and aquatic life warm (41%). Existing recreational uses are not being attained in 34 of the 180 segments (19%), and water supply and agriculture uses are each not being attained in 7 of the 180 segments (4%).

The pollutant types associated with the impairments include heavy metals (selenium, cadmium, copper, zinc, lead, and mercury); other metals such as iron, manganese, and sulfate; arsenic; a radionuclide (uranium); bacteria (*Escherichia coli*); aquatic life use; and more standard indicators of water quality such as pH, sediment, temperature, and dissolved oxygen. Selenium is the pollutant associated with the greatest number of segments (58), followed by *E. coli* (30), cadmium (25), copper (21), zinc (19), and iron (15). Exhibit 3-31 shows the distribution of the pollutants causing impairments across the basins and the number of segments affected in each. Exhibit 3-32 (at end of chapter) shows the impaired segments on a basin map.

Basin **Pollutant** Arkansas Colorado Green San Juan **Rio Grande** Platte Republican Totals¹ River River River River River River River Selenium 17 18 4 19 58 7 19 30 E. coli 1 1 1 1 Cadmium 1 9 1 14 25 Copper 1 2 2 15 21 2 9 1 7 19 Zinc _ Iron 4 2 2 3 2 2 _ 15 1 1 2 4 8 Ηα 4 4 8 Temperature 1 2 3 6 Lead 2 Dissolved Oxygen 1 4 4 4 Arsenic _ _ Sediment 2 2 _ 4 Aquatic Life Use 3 3 Organic Sediment 3 3 Manganese 1 1 2 2 2 Uranium Mercury 1 1 Ammonia 1 _ 1 1 Sulfate 1 215 38 9 10 102 Totals 51 4 1

Exhibit 3-31. Pollutants Causing Impairments by Basin in Terms of Stream Segments Impacted

Sources: WQCC 2010a to 2010h; WQCD 2010a.

In addition to the above, the 2010 Integrated Report identified a total of 39 individual lake/reservoir segments statewide with one or more impairments representing 78,957.2 acres, or 23% and 31% of the total assessed segments and corresponding lake/reservoir acres in the state, respectively. As shown in exhibit 3-33 (at end of chapter), there are 21 aquatic life cold (54%) and 21 aquatic life warm (54%) use impairments and one existing recreational impairment statewide (3%).

As shown in Exhibit 3-34, mercury and dissolved oxygen are more commonly associated with the identified lake impairments, and they are fairly evenly distributed across the basins with respect to the impairments caused. The assessed lakes/reservoirs in the Platte River Basin are exhibiting the greatest number of impairments when compared to the other basins. Because assessments are based on WQCD data as well as third party data and because the amount of WQCD lakes/reservoirs data is relatively uniform across all basins, this greater number of impairments may reflect more third party data available in the Platte River Basin.

Exhibit 3-34. Pollutants Causing Impairments by Basin in Terms of Lake/Reservoir Segments Impacted

	Basin									
Pollutants	Arkansas River	Colorado River	Green River	San Juan River	Rio Grande River	Platte River	Republican River	Totals ¹		
Mercury	3	3	1	4	-	4	-	15		
Dissolved Oxygen	2	2	-	-	2	8	-	14		
Selenium	3	3	-	-	-		-	6		

¹This table reflects total impairments. Because some segments are impaired by more than one pollutant, the totals will not equate to the number of impaired segments.

	Basin									
Pollutants	Arkansas River	Colorado River	Green River	San Juan River	Rio Grande River	Platte River	Republican River	Totals ¹		
Ammonia	-	-	-	-	1	3	-	4		
рН	-	-	-	-	-	3	-	3		
Iron	-	-	-	-	2		-	2		
Arsenic	-	-	-	-	-	1	-	1		
Chlorophyl-a	-	-	-	-	-	1	-	1		
Copper	-	-	-	-	-	1	-	1		
DO-Temp	-	-	-	-	-	1	-	1		
E. coli	-	-	-	-	-	1	-	1		
PCE	1	-	-	-	-		-	1		
Phosphorus	-	-	-	-	-	1	-	1		
Totals	9	8	1	4	5	24	0	51		

¹This table reflects total impairments. Because some segments are impaired by more than one pollutant, the totals will not equate to the number of impaired segments.

Sources: WQCC 2010a to 2010h; WQCD 2010a.

3.3.2 Segments Listed for Further Monitoring and Evaluation

Both Colorado's CWA section 303(d) list of impaired waters and monitoring and evaluation list are contained in WQCC Regulation No. 93: *Section 303(d) List of Impaired Waters and Monitoring and Evaluation List* (5 CCR 1002-93) (WQCC 2010h). The M&E list identifies waterbodies where there is reason to suspect water quality problems but there is some uncertainty regarding whether these waterbodies are impaired. ¹⁵

As shown in exhibit 3-35 (at end of chapter), the monitoring and evaluation list includes 150 segments across the state as requiring additional monitoring and evaluation for one or more parameters. The Platte and the Colorado River Basins have the most segments on the monitoring and evaluation list with 53 (35%) and 44 (29%) segments, respectively. Total recoverable iron and dissolved oxygen are the parameters to be monitored in the most segments (30 segments (20%) each). Total recoverable iron is identified in segments in five of the seven basins (71%), while dissolved oxygen is identified for four basins (57%). The next parameters to be further assessed in the most segments include copper (in 28 segments or 19%), selenium (in 23 segments or 15%), cadmium (in 19 segments or 13 percent), *E. coli* (in 18 segments or 12%), and pH (in 18 segments or 12%). Copper was identified as needing to be assessed in six of the seven basins (86%). Selenium was identified as needing to be evaluated in four of the seven basins (57%), while it identified cadmium as requiring assessment in three of the seven basins (43%).

3.3.3 Known Sources of Stressors

The 2010 Integrated Report identified a total of five sources for the parameters causing impairments—groundwater, mining, natural processes, road runoff, and upstream sources (exhibit 3-36). Two additional categories of sources—not assessed and unknown—are identified, meaning these sources are yet to be determined. The majority of impairments are assigned to

¹⁵ Unlike the CWA section 303(d) list, the M&E list is a state-only document and is not subject to EPA approval.

these two categories (45 and 108, respectively). Of the more specific sources noted, mining is identified as the source for the majority of segments (33). Groundwater, upstream sources, and natural processes are identified for three segments each; road runoff is identified for one segment. Selenium is the most identified parameter, attributed to the following sources; upstream and unknown. Cadmium is the most identified parameter for mining. During the TMDL development process, the sources of the impairments or stressors to water quality will be more specifically identified.

Exhibit 3-36. Identified Sources of Impairments for 2010 Listed Waters

	Number of			
Sources	Segments		nents identified)	
			Arkansas River Basin	
Groundwater	1	PCE (1)		
Not Assessed	1	Copper (1)	pH (1)	Dissolved Oxygen (1)
		Cadmium (1)	Mercury (3)	Uranium (2)
Unknown	31	Lead (1)	E. coli (7)	Sulfate (1)
		Zinc (2)	Selenium (20)	Dissolved Oxygen (temp.) (1)
		Dissolved Oxygen (2)	Iron (4)	
	I	I (a)	Colorado River Basin	(1)
	4-	Zinc (8)	Lead (2)	Manganese (1)
Mining	15	Cadmium (8)	pH (1)	Selenium (7)
D 10 (f		Copper (2)		
Road Runoff	1	Sediment (1)		
Upstream	3	Zinc (1)	Cadmium (1)	Selenium (2)
Source		T (4)	District O. (1)	14(2)
Not Assessed	4	Temperature (1)	Dissolved Oxygen (1)	Mercury (2)
		Temperature (3)	Sediment (1)	Lead (1)
Unknown 23	own 23	Selenium (12)	E. coli (1)	Mercury (1)
		Iron (2)	Zinc (3)	Dissolved Oxygen (1)
		Cadmium (3)	Copper (1)	
		5 (1/4)	Green River Basin	
Mining	1	E. coli (1)		
Not Assessed	2	Iron (1)	Mercury (1)	
Unknown	7	Sediment (2)	Selenium (4)	Iron (1)
		. (0)	San Juan River Basin	(4)
Unknown	8	Iron (3)	Copper (1)	Mercury (4)
	I	- (1)	Rio Grande River Basin	
Mining	4	Copper (1) pH (1)	Cadmium (1)	Iron (1)
Natural Sources	3	Iron (2)	Dissolved Oxygen (1)	
		E. coli (1)	Zinc (1)	Dissolved Oxygen (2)
Unknown	5	Copper (1)	Iron (2)	Ammonia (1)
		pH (1)		
			Platte River Basin	
N 41:1:	12	pH (2)	Zinc (3)	Arsenic (1)
Mining	13	Cadmium (6)	Copper (5)	Lead (1)
Groundwater	2	E. coli (1)	Cadmium (1)	· ·
		Cadmium (4)	Copper (7)	Temperature (1)
		Zinc (3)	Ammonia (3)	Dissolved Oxygen (8)
Not Assessed	20	Sediment (1)	Selenium (9)	Manganese (1)
Not Assessed	38	Arsenic (2)	E. coli (7)	Dissolved Oxygen (temp.) (1)
		Iron (1)	Lead (2)	рН (2)
		Mercury (1)		
		Iron (1)	pH (4)	Zinc (1)
		Dissolved Oxygen (2)	Aquatic Life Use (3)	Mercury (4)
Halman	42	Cadmium (5)	Organic Sediment (2)	Cholorphyll-a (1)
Unknown	42	Arsenic (2)	Temperature (3)	Phosphorus (1)
		E. coli (14)	Copper (3)	Ammonia (1)
		Selenium (12)		
			Republican River Basin	

Sources	Number of Segments	Parameters (number of segments identified)
Not Assessed	1	E. coli (1)

Sources: WQCC 2010a to 2010h; WQCD 2010a.

3.4 TMDLs as Water Protection Strategies

3.4.1 TMDL Basics

As noted previously in chapter 2, "Water Quality Management and Planning in Colorado," CWA section 303(d) requires states to periodically submit to EPA a list of waterbodies that are impaired, meaning that the segment is not meeting the standards for its assigned use classification. The list of impaired waterbodies is referred to as the CWA section 303(d) list. The WQCD prepares the list in conjunction with its biennial Integrated Reports. The WQCC approves and adopts the list as Regulation No. 93: *Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List* (5 CCR 1002-93) (WQCC 2010h).

TMDLs must be developed for waterbodies on the CWA section 303(d) list. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still maintain water quality standards. The TMDL is the sum of the waste load allocation (WLA), which is the load from point source

TMDL Equation

TMDL = WLA + LA + MOS

discharges; the load allocation (LA), which is the load attributed to natural background and/or nonpoint sources; and a margin of safety (MOS).

An important aspect of the TMDL development process includes the identification of the sources of pollutants causing impairments in the waterbody. Both point sources and nonpoint sources are identified.

3.4.2 TMDLs Required to be Developed

Exhibit 3-37 summarizes the number of TMDLs that must be developed based on the waterbodies (streams and lake-only segments) included on the 2010 CWA section 303(d) list, which is also encompassed in the 2010 Integrated Report. The first section of the exhibit shows that statewide a total of 217 impairments occurred in 219 distinct waterbody segments. The 219 waterbody segments represent 27% of the 803 total classified segments in the state. Similar information is provided for each of the basin plans in chapters 6–12 of this SWQMP.

Exhibit 3-37. Statewide and Basin Summary of Impairments, Affected Waterbody Segments, and TMDL Priority Development Status

a	Total Number of Distinct Segments		ected Segments	Lak	fected ke-Only gments	Number of Of Pollutant Causing Impaired Segments		Number of Affected Segments and TMDL Priority Status by Pollutant			
Statewide	Impaired ¹	No. (n=773)	Miles (n=88,788)	No. (n=133)	Acres (n=202,027)		by Pollutant ¹	Low	Medium	High	
ţa						Ammonia	5	2	2	1	
ν						Aquatic Life Use	3	2	1	0	
	217	181	11,113	38	74,922	Arsenic	5	1	0	4	
						Cadmium	25	1	5	19	
						Copper	22	0	6	16	

Statewide	Total Number of Distinct Segments		ected Segments	Affected Lake-Only Segments		of Pollutant Causing Impa	Number of Impaired Segments	of and TMDL paired P		f Affected Segments L Priority Status by Pollutant	
St	Impaired ¹	No. (n=773)	Miles (n=88,788)	No. (n=133)	Acres (n=202,027)		by Pollutant ¹	Low	Medium	High	
						Chlorophyll-a	1	0	1	0	
						Dissolved oxygen	19	4	5	10	
						Dissolved oxygen (temperature)	1	0	0	1	
						E. coli	30	1	0	29	
						Iron	17	4	2	11	
						Lead	6	0	3	3	
						Manganese	2	0	1	1	
						Mercury	16	0	0	16	
						Organic Sediment	3	2	1	0	
						Perchloroethylene (PCE)	1	0	1	0	
						рН	11	1	3	7	
						Phosphorus	1	0	1	0	
						Sediment	4	3	0	1	
						Selenium	64	40	9	15	
						Sulfate	1	1	0	0	
						Temperature	8	1	1	6	
						Uranium	2	1	0	1	
						Zinc	19	0	5	14	
						Total No. TMDLs to Be Developed	266	64	47	155	
Impaired Segreent of Total	tal Segments	23%	13%	29%	37%	Affected Segments of TMDL Priorit		24%	18%	58%	

¹When the total number of TMDLs to be developed is greater than the total number of distinct segments impaired, it typically means that one or more of the impaired individual segment s is impaired by more than one pollutant. When the total number of TMDLs to be developed is less than the total number of distinct segments impaired, it typically means that one or more individual segments were identified as impaired in a previous CWA section 303(d) listing cycle. However, in the latest monitoring cycle the segments showed that they are not meeting the standard(s) for one or more assigned use classifications.

Sources: WQCC 2010h; WQCD 2010a, appendices A to D.

3.4.3 TMDLs Completed to Date

The WQCD has completed TMDLs for an array of parameters across the state's major river basins. The TMDLs completed are summarized in exhibit 3-38. The greatest number of TMDLs completed has been in the Colorado and Platte River Basins at 25 and 23, respectively. The heavy metals, zinc, copper, cadmium and lead are the parameters most frequently the subject of the TMDLs that have been completed to date (affecting 44, 30, 29 and 16 segments, respectively). Summaries of some of the TMDLs completed to date are provided in chapters 6–12 of the SWQMP.

Exhibit 3-38. Summary of TMDLs Completed to Date by River Basin

Basin (basin plan chapter)	Number of Segments	Parameters	Number of Segments with TMDL for Parameter
		Lead	3
	10	Zinc	8
Aulanaa Diraa		Cadmium	5
Arkansas River (ch. 6)		Dissolved Oxygen	1
(Cn. 6)		рH	2
		Copper	2
		Aluminum	1

Basin	Number of Segments	Parameters	Number of Segments with
(basin plan chapter)		Ammonia	TMDL for Parameter
		Ammonia Cadmium	<u>1</u> 5
		Zinc	9
		Copper	8
		Lead	2
Colorado River	25	рН	2
(ch. 7)	25		1
		Manganese Sediment	1
		Selenium	12
		Iron (Trec)	1
		Zinc (sculpin)	1
Green River			ted to date in the Green River
(ch. 8)	0	Basin.	ted to date in the Green River
(cn. o)		Sediment	2
		Mercury	2
		Aluminum	4
		Cadmium	6
San Juan River	15		6
(ch. 9)	13	Copper	6
		Lead	4
			2
		pH Zinc	8
			3
		Cadmium Zinc	6
	11		
D's Conside D's se		Mercury	1
Rio Grande River		Aluminum	3
(ch. 10)		Copper	7
		Lead	2
		pH	5
		Silver	1
		Sediment	3
		Cadmium	10
		Lead	5
		Zinc	13
-1 ··· -1		Iron	3
Platte River	23	Manganese	5
(ch. 11)		Copper	7
		pH	3
		E. coli	1
		Nitrate	1
		Dissolved Oxygen	1
		Ammonia	3
Republican River	0	I and the second	ted to date in the Republican
(ch. 12)		River Basin.	
		Aluminum	0
		Aluminum	8
		Ammonia	4
		Cadmium	29
		Copper	30
		Dissolved Oxygen	2
		E. coli	2
		Iron	9
Statewide Totals	84	Iron (Trec)	1
		Lead	16
		Manganese	6
		Mercury	3
		Nitrate	1
		pH	14
		Sediment	6
		Selenium	12
		Silver	1

Basin (basin plan chapter)	Number of Segments	Parameters	Number of Segments with TMDL for Parameter
		Zinc	44
		Zinc (sculpin)	1
		Total	189

Sources: WQCC 2010h; WQCD 2002, 2008, and 2010a.

3.4.4 TMDL Implementation Strategies

Currently, TMDLs are directly implemented only with respect to permitted point source discharges. In those instances where impairment has been attributable to one or more permitted point sources TMDL implementation has occurred via the inclusion of relevant permit requirements (e.g. effluent limits and/or compliance schedules). Several TMDLs addressing ammonia or nitrate impairments have been implemented in this fashion. Examples include a TMDL written to address an unnamed tributary to Willow Creek in the upper Colorado River watershed, and nitrate and E. coli TMDLs prepared for segment 14 of the upper South Platte River basin.

Many TMDLs in Colorado address impairments stemming from legacy mining operations. These operations are typically characterized as abandoned mined lands and are treated as unpermitted point source discharges by the Division. In the absence of a responsible party it often falls to a third party to address the situation on a voluntary basis. Federal agencies (EPA or BLM), the Colorado Division of Reclamation, Mining and Safety or non-governmental third parties may pursue remediation of relict mining operations. Parties undertaking these activities may pursue a myriad of funding, design and construction options. The TMDL document will typically incorporate a summary of ongoing remedial efforts, but lacking any regulatory basis to do there is no attempt to use the TMDL process to direct any such efforts. Nonetheless, the Division has completed a number of TMDLs which have been coordinated with mined land remediation activities. A number of these watersheds, i.e. Kerber Creek, are verging on attainment of their assigned water quality standards.

The Division has completed several TMDLs that address primarily non-point source contributions of pollutants. At present, TMDLs concerning sediment loading to Straight Creek (a tributary to the Blue River that parallels I-70), and Box Canyon Creek in the San Juan National Forest have been implemented. This is due in largest part to the willingness of state and federal agencies to assume responsibility for implementation efforts. Both of the waterbodies identified have exhibited a position response to remedial actions, in the latter case the stream is now in attainment of water quality standards.

There remains a subset of TMDLs that concern airborne pollutants that cause or contribute to water quality impairments. At present the pollutant of concern is mercury. The Division has completed several "phased" TMDLs for reservoirs in southwest Colorado where levels of mercury in fish tissue represent a human health hazard. EPA approval of these phased TMDL requires specific monitoring strategies be devised and implemented. In these instances additional monitoring was necessary to quantify the levels of mercury deposition that occurs and that is not associated with precipitation. Funding to address TMDL implementation, especially those involving nonpoint source and unpermitted points source discharges (legacy mining) issues is limited, and impacts the ability of the WQCD and other interested parties to address these issues.

The basin plans in chapters 6–12 provide exhibits that summarize activities identified in completed TMDLs as restoration or protection water quality strategies. Chapter 4 of the SWQMP provides a synopsis of strategies that can be employed or activities undertaken to address specific types of problems. Appendix E to the SWQMP provides additional resource information on this topic.

3.5 Planned Point Source Treatment Upgrades

As shown in exhibit 3-39, there are a total of 778 public and private point source dischargers in Colorado. The Platte River Basin, by far, has the greatest number, followed by the Arkansas and Colorado River basins. The basin plans in chapters 6–12 provide a breakdown of point sources by applicable county.

Exhibit 3-39. Number of Point Sources by Basin¹

Exhibit 3-33. Number of Foliat Sources by Dasin							
Basin (basin plan chapter number)	No. Counties with Point Sources	No. of Point Sources					
Arkansas River (ch. 6)	18	159					
Colorado River (ch. 7)	13	130					
Green River (ch. 8)	4	32					
San Juan River (ch. 9)	11	60					
Rio Grande River (ch. 10)	6	28					
Platte River (ch. 11)	22	348					
Republican River (ch. 12)	7	21					
Statewide Total		778					

¹ WQCD does not currently have an electronic file of all point sources in Colorado. The point sources included in the exhibit were culled from several databases (see source information).

Sources: USEPA 2010a, 2010c; WQCD 2010b.

Congress authorized the Clean Water State Revolving Fund (CWSRF; called the Water Pollution Control Revolving Fund, or WPCRF, in Colorado) when amending the CWA in 1987. The purpose of the CWSRF is to help provide financial assistance to governmental agencies for the construction of projects that are listed in the state's annual Intended Use Plans (IUPs). The Project Eligibility List included in the IUPs is made up of projects for construction of publicly owned treatment works and projects/activities eligible for assistance under CWA sections 319 and 320.

A total of 459 planned treatment projects, at an estimated value of \$2.2 billion, were identified for point source facilities in Colorado. Exhibit 3-40 provides a summary of the project types and includes the number of projects, the estimated costs of the projects, and the population expected to benefit. The four project types are (1) wastewater treatment facility, (2) nonpoint source, (3) stormwater, and (4) source water protection. Wastewater treatment facility projects lead the list in terms of the greatest number of scheduled projects (353 of 459, or 77%) and the greatest share of resources (\$2 billion or 91%). Stormwater projects follow with 48 projects (10.5%) at a total cost of \$174 million (8% of total project funds). Scheduled nonpoint source projects include 30 of the 459 projects (7%) and \$50.6 million of the \$2.2 billion (2%). Scheduled source water protection projects include 27 of the 459 projects (6%) and \$1.4 million of the \$2.2 billion (less than 1%).

Exhibit 3-40. Statewide Summary of Scheduled Point Source Improvement Projects

Basin	No. of Projects	Estimated Costs of Projects		
Wastewater Treatment Facility Projects				
Arkansas River	83	\$392,215,377		
Colorado River	66	\$276,631,877		
Green River	15	\$46,178,571		
San Juan River	24	\$85,244,278		
Rio Grande River	18	\$24,706,468		
Platte River	126	\$1,153,693,820		
Republican River	21	\$24,356,100		
Totals	353	\$2.0 billion		
Nonpoint Source Projects ¹				
Arkansas River	4	\$8,411,983		
Colorado River	7	\$15,090,000		
Green River	0	\$0.0		
San Juan River	5	\$2,850,000		
Rio Grande River	0	\$0.0		
Platte River	12	\$23,525,000		
Republican River	2	\$750,000		
Totals	30	\$50.6 million		
Stormwater ²				
Arkansas River	8	\$51,692,098		
Colorado River	9	\$11,100,000		
Green River	1	\$1,350,000		
San Juan River	1	\$500,000		
Rio Grande River	3	\$13,808,000		
Platte River	23	\$91,693,467		
Republican River	3	\$4,115,041		
Totals	48	\$174.3 million		
Source Water Protection				

¹⁶ Projects identified include only those on the state's IUP. Therefore, the list is not likely inclusive of all projects that may be occurring in the state.

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Basin	No. of Projects	Estimated Costs of Projects			
Arkansas River	17	\$245,000			
Colorado River	2	\$300,000			
Green River	0	\$0.0			
San Juan River	0	\$0.0			
Rio Grande River	1	\$52,000			
Platte River	2	\$820,000			
Republican River	5	60,000			
Totals	27	\$1.4 million			
Total all Projects					
Arkansas River	113	\$452,564,458			
Colorado River	84	\$303,121,877			
Green River	16	\$47,528,571			
San Juan River	30	\$88,594,278			
Rio Grande River	22	\$38,566,468			
Platte River	163	\$1,269,732,287			
Republican River	31	\$29,281,141			
Totals	459	\$2.2 billion			

¹ Nonpoint source projects do not include projects funded through CWA Section 319

3.6 Nonpoint Source Management

Exhibit 3-41 summarizes CWA section 319 nonpoint source grant projects identified as occurring in the state's seven major river basins over the past 5 years. Projects in the Platte, Colorado, and Arkansas River Basins received the greatest proportion of overall grant funds made available, probably due to the size and condition of the watersheds. Watershed planning projects are among those most frequently funded (15 out of the 51, or 30%). The basin plans in chapters 6–12 of the SWQMP contain additional details regarding the projects identified.

Exhibit 3-41. Summary of CWA Section 319 Nonpoint Source Grant Projects by Basin

Basin (basin plan chapter number)	Number of Projects Identified	Fiscal Year(s)	Functional Categories	Total Budget	CWA Section 319(h) Portion	Other Funding
Arkansas River (ch. 6)	6	2006-2008	 Watershed Planning (2) Other Restoration / Protection / Prevention (1) BMP Design and Implementation (2) Other (1) 	\$2,135,713	\$1,028,979	\$1,104,734
Colorado River (ch. 7)	18	2005-2010	 Stormwater Discharge Design & Control (1) TMDLs (2) BMP Design and Implementation (3) Watershed Planning (4) Other Water Quality Assessment / Monitoring (1) Other Restoration / Protection / Prevention (1) 	\$2,395,822	\$581,478	\$1,814,344

² Stormwater projects address both point and nonpoint sources. Sources: USEPA 2010a, 2010c; WQCD 2010b.

Basin (basin plan chapter	Number of Projects	Fiscal Year(s)	Functional Categories	Total Budget	CWA Section 319(h) Portion	Other Funding
number)	Identified		 Stream Restoration (2) Not Applicable (2) None Specified (2) 			
Green River (ch. 8)	0					
San Juan River (ch. 9)	6	2005-2008	 BMP Design and Implementation (1) Watershed Planning (3) Other Water Quality Assessment and Monitoring (1) Stream Restoration (1) 	\$928,371	\$552,753	\$375,618
Rio Grande River (ch. 10)	4	2005-2010	 BMP Design and Implementation (1) Watershed Modeling (1) Watershed Planning (2) 	\$537,791	\$222,723	\$315,068
Platte River (ch. 11)	17	2005-2010	 BMP Design and Implementation (4) Watershed Planning (4) Stream Restoratoin (1) Watershed Modeling / Assessments (1) Local (Specific Target) / Education (1) Streambank Stabilization (3) Hydromodification (1) Urban/Stormwater (1) Not Applicable (1) 	\$3,979,110	\$1,515,583	\$2,453,527
Republican River (ch. 12)	0					
Statewide Totals	51	2005-2010	 Watershed Planning (15) BMP Design an d Implementation (11) Stream Restoration (4) Streambank Stabilization (3) Not Applicable (3) TMDLs (2) Watershed Modeling / Assessments (2) None Specified (2) Other Restoration / Protection / Prevention (2) Other Water Quality Assessment and Monitoring (2) Hydromodification (1) Local (Specific Target) / Education (1) Stormwater Discharge Design and Control (1) Urban / Stormwater (1) Other (1) 	\$9,976,807	\$3,901,516	\$6,063,291

Sources: USEPA 2010b; WQCD 2010a.

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